CLAIMS

What is claimed is:

1. A method for determining one or more fine-tuned estimates of delay value associated with a received signal, the method comprising the computer-implemented steps of:
determining a range of delay values of interest associated with the received signal;
interpolating fine-grained values for I and Q correlation integrals by using a subset of coarse-grained calculations of I and Q correlation integrals; and
determining the one or more fine-tuned estimates of delay value based on the fine-grained values of I and Q correlation integrals.

2. The method of Claim 1, wherein determining a range of delay values of interest further comprises the steps of:
determining one or more initial estimates of the delay value;
selecting one of the one or more initial estimates of delay value to be a selected initial estimate of delay value; and
selecting a range of delay values in the neighborhood of the selected initial estimate of delay value to be the range of delay values of interest.

3. The method of Claim 2, wherein selecting a range of delay values in the neighborhood of the selected initial estimate of delay value to be the range of delay values of interest is a function of the selected initial estimate of delay value and a pre-selected confidence level.

4. The method of Claim 1, wherein the subset of coarse-grained calculations of I and Q correlation integrals is based on:

a pre-selected desired accuracy; and

a type of filter that was used to filter the received signal.

5. The method of Claim 2, wherein determining the one or more initial estimates of the delay value further comprises the steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of delay values for a sampled data that is associated with the received signal;

calculating magnitude values corresponding to the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of delay values; and

selecting a delay value that corresponds to a highest magnitude value corresponding to the coarse-grained calculations of I and Q correlation integrals as the one or more initial estimates of delay value.

6. The method of Claim 2, wherein determining the one or more initial estimates of delay value further comprises the steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of delay values for a sampled data that is associated with the received signal;

calculating magnitude values corresponding to the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of delay values; and

selecting one or more delay values that correspond to magnitude values that are above a pre-selected threshold magnitude value as the one or more initial estimates of delay value.

7. The method of Claim 2, wherein determining the one or more initial estimates of the delay value further comprises the steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of delay values for a sampled data that is associated with the received signal;

calculating magnitude values corresponding to the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of delay values;

determining a highest magnitude value corresponding to the coarse-grained calculations of I and Q correlation integrals; and

selecting one or more delay values that correspond to magnitude values that are within a pre-selected magnitude range around the highest magnitude value as the one or more initial estimates of delay value.

8. The method of Claim 5, wherein the hypothesized range of delay values is based on:

an approximate time when a receiver received the received signal;

a time uncertainty quantity that is associated with the approximate time;

an approximate position of the receiver; and

an position uncertainty quantity that is associated with the approximate position of the receiver.

9. The method of Claim 1, wherein interpolating fine-grained values for I and Q correlation integrals is based on a bandlimited interpolation technique.

10. The method of Claim 1, wherein the received signal is associated with a global positioning satellite vehicle.

11. The method of Claim 1, wherein determining the one or more fine-tuned estimates delay value based on the fine-grained values of I and Q correlation integrals comprises the steps of:

calculating magnitude values corresponding to the fine-grained values of I and Q correlation integrals over the range of delay values of interest; and

selecting one or more delay values that corresponds to a highest magnitude value corresponding to the fine-grained values of I and Q correlation integrals as the one or more fine-tuned estimates delay value.

12. The method of Claim 1, wherein determining one or more fine-tuned estimates delay value based on the fine-grained values of I and Q correlation integrals comprises the steps of:

calculating magnitude values corresponding to the fine-grained values of I and Q correlation integrals over the range of delay values of interest; and

selecting one or more delay values that correspond to magnitude values that are above a pre-selected threshold magnitude value as the one or more fine-tuned estimates of delay value.

13. The method of Claim 1, wherein determining one or more fine-tuned estimates delay value based on the fine-grained values of I and Q correlation integrals comprises the steps of:

calculating magnitude values corresponding to the fine-grained values of I and Q correlation integrals over the range of delay values of interest;

determining a highest magnitude value corresponding to the fine-grained values of I and Q correlation integrals; and

selecting one or more delay values that corresponds to magnitude values that are within a pre-selected magnitude range around the highest magnitude value as the one or more fine-tuned estimates of delay value.

14. A method for determining one or more fine-tuned estimates of delay value associated with a received signal, the method comprising the computer-implemented steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of delay values for a sampled data that is associated with the received signal;

calculating a magnitude of the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of delay values; and

selecting a delay value from the hypothesized range of delay values that correspond to a highest magnitude value that corresponds to the coarse-grained calculations of I and Q correlation integrals as an initial estimate of delay value;

selecting a range of delay values in the neighborhood of the initial estimate of delay value to be a range of delay values of interest;

interpolating fine-grained values for I and Q correlation integrals by using a subset of coarse-grained calculations of I and Q correlation integrals;

calculating magnitude values corresponding to the fine-grained values of I and Q correlation integrals over the range of delay values of interest; and

selecting one or more delay values that corresponds to a highest magnitude value corresponding to the fine-grained values of I and Q correlation integrals as the one or more fine-tuned estimates delay value.

15. A method for determining one or more fine-tuned estimates of delay value associated with a received signal, the method comprising the computer-implemented steps of:

determining an initial range of delay values of interest associated with the received signal;

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over the initial range of delay values for a sampled data that is associated with the received signal;

calculating a magnitude of the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of delay values; and

selecting a delay value from the hypothesized range of delay values that correspond to a highest magnitude value that corresponds to the coarse-grained calculations of I and Q correlation integrals as an initial estimate of delay value;

selecting a range of delay values in the neighborhood of the initial estimate of delay value to be a range of delay values of interest;

generating a parametric template that represents I and Q correlation integrals associated with the received signal; and

performing a linear regression on the range of delay values of interest to produce a delay error function that is based on the range of delay values of interest; and

selecting from the range of delay values of interest one or more delay values that minimize the delay error function as the fine-tuned estimates of delay value.

16. The method of Claim 15, wherein the step of selecting from the range of delay values of interest one or more delay values that minimize the delay error function comprises the steps of:

from the range of delay values of interest, selecting a target delay value that produces a minimum value of the delay error function; and

from the range of delay values of interest, selecting a range of delay values around the target delay value as the one or more fine-tuned estimates of delay value.

17. The method of Claim 15, wherein the step of selecting from the range of delay values of interest one or more delay values that minimize the delay error function comprises the steps of:

selecting from the range of delay values of interest one or more delay values for which the delay error function is below a pre-selected threshold value of the delay error function as the one or more fine-tuned estimates delay value.

18. A method for determining one or more fine-tuned estimates of carrier frequency value associated with a received signal, the method comprising the computer-implemented steps of:

determining a range of carrier frequency values of interest associated with the received signal;

interpolating fine-grained values for I and Q correlation integrals by using a subset of coarse-grained calculations of I and Q correlation integrals; and

determining the one or more fine-tuned estimates of carrier frequency value based on the fine-grained values of I and Q correlation integrals.

19. The method of Claim 18, wherein determining a range of carrier frequency values of interest further comprises the steps of:

determining one or more initial estimates of carrier frequency value;

selecting one of the one or more initial estimates of carrier frequency value to be a selected initial estimate of carrier frequency value; and

selecting a range of carrier frequency values in the neighborhood of the selected initial estimate of carrier frequency value to be the range of carrier frequency values of interest.

20. The method of Claim 18, wherein the subset of coarse-grained calculations of I and Q correlation integrals is based on:

duration of the I and Q correlation integral;

a pre-selected confidence level; and

a type of filter that was used to filter the received signal.

21. The method of Claim 19, wherein determining the one or more initial estimates of carrier frequency value further comprises the steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of carrier frequency values for a sampled data that is associated with the received signal;

calculating magnitude values corresponding to the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of carrier frequency values; and

selecting a carrier frequency value that corresponds to a highest magnitude value corresponding to the coarse-grained calculations of I and Q correlation integrals as the one or more initial estimates of carrier frequency value.

22. The method of Claim 19, wherein determining the one or more initial estimates of carrier frequency value further comprises the steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of carrier frequency values for a sampled data that is associated with the received signal;

calculating magnitude values corresponding to the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of carrier frequency values; and

selecting one or more carrier frequency values that correspond to magnitude values that are above a pre-selected threshold magnitude value as the one or more initial estimates of carrier frequency value.

23. The method of Claim 19, wherein determining the one or more initial estimates of carrier frequency value further comprises the steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of carrier frequency values for a sampled data that is associated with the received signal;

calculating magnitude values corresponding to the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of carrier frequency values;

determining a highest magnitude value corresponding to the coarse-grained calculations of I and Q correlation integrals; and

selecting one or more carrier frequency values that correspond to magnitude values that are within a pre-selected magnitude range around the highest magnitude value as the one or more initial estimates of carrier frequency value.

24. The method of Claim 18, wherein the received signal is associated with a global positioning satellite vehicle.

25. The method of Claim 18, wherein determining the one or more fine-tuned estimates of carrier frequency value based on the fine-grained values of I and Q correlation integrals comprises the steps of:

calculating magnitude values corresponding to the fine-grained values of I and Q correlation integrals over the range of carrier frequency values of interest; and

selecting one or more carrier frequency value that correspond to a highest magnitude value corresponding to the fine-grained values of I and Q correlation integrals as the one or more fine-tuned estimates carrier frequency value.

26. The method of Claim 18, wherein determining one or more fine-tuned estimates of carrier frequency value based on the fine-grained values of I and Q correlation integrals comprises the steps of:

calculating magnitude values corresponding to the fine-grained values of I and Q correlation integrals over the range of carrier frequency values of interest; and

selecting one or more carrier frequency values that correspond to magnitude values that are above a pre-selected threshold magnitude value as the one or more fine-tuned estimates carrier frequency value, respectively.

27. The method of Claim 18, wherein determining one or more fine-tuned estimates of carrier frequency value based on the fine-grained values of I and Q correlation integrals comprises the steps of:

calculating magnitude values corresponding to the fine-grained values of I and Q correlation integrals over the range of carrier frequency values of interest;

determining a highest magnitude value corresponding to the fine-grained values of I and Q correlation integrals; and

selecting one or more carrier frequency values that correspond to magnitude values that are within a pre-selected magnitude range around the highest magnitude value as the one or more fine-tuned estimates carrier frequency value.

28. A method for determining one or more fine-tuned estimates of carrier frequency value associated with a received signal, the method comprising the computer-implemented steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of carrier frequency values for a sampled data that is associated with the received signal;

calculating a magnitude of the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of carrier frequency value; and

selecting a carrier frequency value from the hypothesized range of carrier frequency value that correspond to a highest magnitude value that corresponds to the coarse-grained calculations of I and Q correlation integrals as an initial estimate of carrier frequency value;

selecting a range of carrier frequency values in the neighborhood of the initial estimate of carrier frequency value to be a range of carrier frequency values of interest;

interpolating fine-grained values for I and Q correlation integrals by using a subset of coarse-grained calculations of I and Q correlation integrals;

calculating magnitude values corresponding to the fine-grained values of I and Q correlation integrals over the range of carrier frequency values of interest; and

selecting one or more carrier frequency value that corresponds to a highest magnitude value corresponding to the fine-grained values of I and Q correlation integrals as the one or more fine-tuned estimates carrier frequency value.

29. A method for determining one or more fine-tuned estimates of carrier frequency value associated with a received signal, the method comprising the computer-implemented steps of:

determining an initial range of carrier frequency values of interest associated with the received signal;

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over the initial range of carrier frequency values for a sampled data that is associated with the received signal;

calculating a magnitude of the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of carrier frequency values; and

selecting a carrier frequency value from the hypothesized range of carrier frequency values that correspond to a highest magnitude value that corresponds to the coarse-grained calculations of I and Q correlation integrals as an initial estimate of carrier frequency value;

selecting a range of carrier frequency values in the neighborhood of the initial estimate of carrier frequency value to be a range of carrier frequency values of interest;

generating a parametric template that represents I and Q correlation integrals associated with the received signal;

performing a linear regression on the range of carrier frequency values of interest to produce a carrier frequency error function that is based on the range of carrier frequency values of interest; and

selecting from the range of carrier frequency values of interest one or more carrier frequency values that minimize the carrier frequency error function as the fine-tuned estimates of carrier frequency value.

30. The method of Claim 29, wherein the step of selecting from the range of carrier frequency values of interest one or more carrier frequency values that minimize the carrier frequency error function comprises the steps of:

from the range of carrier frequency values of interest, selecting a target carrier frequency value that produces a minimum value of the carrier frequency error function; and

from the range of carrier frequency values of interest, selecting a range of carrier frequency values around the target carrier frequency value as the one or more fine-tuned estimates of carrier frequency value.

31. The method of Claim 29, wherein the step of selecting from the range of carrier frequency values of interest one or more carrier frequency values that minimize the carrier frequency error function comprises the steps of:

selecting from the range of carrier frequency values of interest one or more carrier frequency values for which the carrier frequency error function is below a pre-selected threshold value of the carrier frequency error function as the one or more fine-tuned estimates carrier frequency value.

32. A method for determining one or more fine-tuned estimates of parameter values associated with a received signal, the method comprising the computer-implemented steps of:

determining a range of parameter values of interest associated with the received signal;

interpolating fine-grained values for I and Q correlation integrals by using a subset of coarse-grained calculations of I and Q correlation integrals; and

determining the one or more fine-tuned estimates of parameter value based on the fine-grained values of I and Q correlation integrals.

33. The method of Claim 32, wherein parameter values comprise a vector including all or a subset of multipath characteristics, signal power, delay, and carrier frequency.

34. The method of Claim 32, wherein determining a range of parameter values of interest further comprises the steps of:

determining one or more initial estimates of the parameter value;

selecting one of the one or more initial estimates of parameter value to be a selected initial estimate of parameter value; and

selecting a range of parameter values in the neighborhood of the selected initial estimate of parameter value to be the range of parameter values of interest.

35. The method of Claim 34, wherein selecting a range of parameter values in the neighborhood of the selected initial estimate of parameter value to be the range of

parameter values of interest is a function of the selected initial estimate of parameter value and a pre-selected confidence level.

36. The method of Claim 34, wherein determining the one or more initial estimates of the parameter value further comprises the steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of parameter values for a sampled data that is associated with the received signal;

calculating magnitude values corresponding to the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of parameter values; and

selecting a parameter value that corresponds to a highest magnitude value corresponding to the coarse-grained calculations of I and Q correlation integrals as the one or more initial estimates of parameter value.

37. The method of Claim 34, wherein determining the one or more initial estimates of parameter value further comprises the steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of parameter values for a sampled data that is associated with the received signal;

calculating magnitude values corresponding to the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of parameter values; and

selecting one or more parameter values that correspond to magnitude values that are above a pre-selected threshold magnitude value as the one or more initial estimates of parameter value.

38. The method of Claim 34, wherein determining the one or more initial estimates of the parameter value further comprises the steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of parameter values for a sampled data that is associated with the received signal;

calculating magnitude values corresponding to the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of parameter values;

determining a highest magnitude value corresponding to the coarse-grained calculations of I and Q correlation integrals; and

selecting one or more parameter values that correspond to magnitude values that are within a pre-selected magnitude range around the highest magnitude value as the one or more initial estimates of parameter value.

39. A method for determining one or more fine-tuned estimates of parameter value associated with a received signal, the method comprising the computer-implemented steps of:

determining an initial range of parameter values of interest associated with the received signal;

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over the initial range of parameter values for a sampled data that is associated with the received signal;

calculating a magnitude of the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of parameter values; and

selecting a parameter value from the hypothesized range of parameter values that correspond to a highest magnitude value that corresponds to the coarse-grained calculations of I and Q correlation integrals as an initial estimate of parameter value;

selecting a range of parameter values in the neighborhood of the initial estimate of parameter value to be a range of parameter values of interest;

generating a parametric template that represents I and Q correlation integrals associated with the received signal; and

performing a linear regression on the range of parameter values of interest to produce a parameter error function that is based on the range of parameter values of interest; and

selecting from the range of parameter values of interest one or more parameter values that minimize the parameter error function as the fine-tuned estimates of parameter value.

40. The method of Claim 39, wherein the step of selecting from the range of parameter values of interest one or more parameter values that minimize the parameter error function comprises the steps of:

from the range of parameter values of interest, selecting a target parameter value that produces a minimum value of the parameter error function; and

from the range of parameter values of interest, selecting a range of parameter values around the target parameter value as the one or more fine-tuned estimates of parameter value.

41. The method of Claim 39, wherein the step of selecting from the range of parameter values of interest one or more parameter values that minimize the parameter error function comprises the steps of:

selecting from the range of parameter values of interest one or more parameter values for which the parameter error function is below a pre-selected threshold value of the parameter error function as the one or more fine-tuned estimates parameter value.